47TH CONGRESS, 1st Session. | SENATE. | EX. DOC. No. 126.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

A report of S. T. Abert, United States civil engineer, upon a survey of the Potomac River in the vicinity of Washington, with reference to the improvement of navigation, the establishment of harbor lines, and the raising of the flats; also the preliminary report of a Board of Engineer officers on the same subject.

MARCH 9, 1882.—Referred to the Select Committee on the Potomac Flats and ordered to be printed.

WAR DEPARTMENT,
Washington City, March 8, 1882.

The Secretary of War has the honor to transmit to the United States Senate, for the information of the Committee on Commerce, a communication from the Chief of Engineers of yesterday's date, covering a copy of the report of Mr. S. T. Abert, United States civil engineer, upon a survey made in compliance with requirements in the river and harbor act of March 3, 1881, of the Potomac River in the vicinity of Washington, with reference to the improvement of navigation, the establishment of harbor lines, and the raising of the flats; also a copy of the preliminary report of a Board of Engineer officers on the same subject.

ROBERT T. LINCOLN,
Secretary of War.

The PRESIDENT *pro tempore*
of the United States Senate.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 7, 1882.

SIR: I have the honor to submit herewith a copy of a report to this office from Mr. S. T. Abert, United States civil engineer, of the results of a survey made under his direction, to comply with requirements of the river and harbor act of March 3, 1881, of the Potomac River in the vicinity of Washington, with reference to the improvement of navigation, the establishment of harbor lines, and the raising of the flats.

By your authority, in view of the interest felt in this improvement,

this report of Mr. Abert was referred to a Board of Engineer officers, with instructions to give the whole subject careful consideration. A copy of the Board's preliminary report thereon, with accompanying papers, is also submitted herewith and commended for favorable consideration.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers, Brig. and Bvt. Maj. Gen.

Hon. ROBERT T. LINCOLN,
Secretary of War.

SURVEY OF POTOMAC RIVER BETWEEN THE ACQUEDUCT BRIDGE AND GEISBOROUGH POINT.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., January 17, 1882.

GENERAL: The act of appropriation for rivers and harbors approved March 3, 1881, contains a provision for a survey of the "Potomac and Anacostia rivers in the vicinity of Washington, D. C., with reference to the improvement of navigation, the establishment of the harbor line, and the raising of the flats so far as their improvement may be necessary to the improvement of navigation and the establishment of the harbor line."

This duty was assigned to me by your letter of March 21, 1881.

I have the honor to submit herewith a brief summary of the results obtained by this survey between the Aqueduct Bridge and Geisborough Point, together with a plan and estimate for the improvement of the navigation and the raising of the flats and for establishing the harbor lines of Washington City. These results and the estimates for the improvement of Washington Harbor are transmitted at the present time, in order that they may be laid before Congress in time for early consideration.

The remainder of the report, relating to the Anacostia River and to that part of the Potomac River between the outlet lock and inclined plane of the Chesapeake and Ohio Canal (together with additional data in regard to the harbors of Washington and Georgetown), will be transmitted as soon as it is completed.

The survey was commenced at the inclined plane of the Chesapeake and Ohio Canal above Georgetown, on the Potomac River, and at the Anacostia Bridge, on the Anacostia River, and terminated at Giesborough Point, where the two rivers unite. The shore lines, bridges, wharves, &c., were located, and 37 cross-sections taken. On these cross-sections soundings were taken every 50 feet, the distance being measured by means of a small wire rope. Velocity observations for ebb and flood tide were taken at each cross-section. Tidal observations were taken during the progress of the survey at the outlet lock, Aqueduct Bridge, G-street Wharf, the Long Bridge, Arsenal Point, and at the navy-yard. The following tabular statement shows the locations at which the cross-sections were taken, the widths at low-water, the maximum depth at low-water, and the sectional areas at low tide, high tide, and during the freshets of 1881 and 1877. In explanation of this table it should be stated that below Easby's Point the width of the river increases from 974 feet to about 5,000 feet, losing its distinctive fluvial character, and

expanding into the wide tidal area known as the harbors of Washington and Georgetown.

The sectional areas of high tide and of freshet below Easby's Point do not, therefore, represent the area of discharge which must be provided for in the improvement, as here the freshet water simply flowed over this wide extent of flats and marshes at a greatly reduced velocity. The altitude of the freshet of February, 1881, was maintained as indicated in the table by the ice-gorges at and *below* the Long Bridge. The cross section of the Washington and the Georgetown channels, into which the river divides, and of the flats between them, are separately indicated in the table.

Tabular statement of cross-sections of Potomac River between Aqueduct bridge and the Arsenal wharf.

Locality.	Width at low-water.	Maximum depth at low-water.	Height of freshet of 1881 above low-water.	Height of freshet of 1877 above low-water.	Sectional area, low-water.			Total.	Sectional area at high-tide.	Sectional area at freshet line of 1881.	Sectional area at freshet line of 1877.	Remarks.	No. of section or profile.
					Georgetown channel.	Washington channel.	Flats.						
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*		
Aqueduct Bridge	900	24.5	14.03	16.5	16,917	.....	.....	16,917	22,504	34,779	35,253	Under bridge.....	9–10
Consolidation Coal Company's wharf	1,080	25.5	13.91	.....	20,757	.....	.....	20,757	24,170	51,462	.....		11–12
Fish wharf, Georgetown	930	35.0	13.67	.....	18,964	.....	.....	18,964	21,783	33,456	.....		13–14
Potomac Boat Club house	707	38.3	13.77	.....	20,416	.....	.....	20,416	22,546	33,422	.....		15–16
Outlet lock, Rock Creek	800	32.0	13.74	.....	19,366	.....	.....	19,366	21,841	41,417	.....	To wharf line.....	17–18
G-street wharf, Washington	945	29.6	13.71	13.0	19,051	.....	.....	19,051	22,770	41,619	42,080	To wharf line	19–20
Easby's wharf	974	35.5	13.39	.....	17,341	.....	.....	17,341	21,343	38,818	.....		21–22
Opposite southwest corner Observatory wall	1,250	31.1	13.00	.....	19,165	.....	.....	19,165	29,267	69,754	.....		23–24
Opposite southeast corner Observatory wall	1,500	23.4	12.81	.....	19,219	.....	.....	19,219	31,675	76,488	.....		25–26
5,250 feet above Long Bridge	2,280	16.0	12.61	10.2	20,915	.....	.....	20,915	35,780	90,792	75,414		27–28
4,200 feet above Long Bridge	3,350	17.6	12.52	.....	22,386	.....	.....	22,386	36,459	90,037	.....		29–30
2,900 feet above Long Bridge	4,500	18.5	12.42	.....	20,205	3,792	.....	23,997	40,887	102,740	.....		31–32
2,000 feet above Long Bridge	6,140	20.3	12.31	.....	20,370	4,140	.....	24,510	43,284	134,124	.....		33–34
80 feet above Long Bridge	4,860	27.2	12.26	9.1	21,051	4,662	1,826	27,539	42,158	124,424	148,400		35–36
Tenth-street wharf	3,176	29.8	11.20	.....	20,726	5,913	.....	26,639	41,412	116,366	.....		37–38
N-street wharf	5,140	26.9	10.42	.....	15,913	6,017	3,363	25,293	40,713	90,927	.....		39–40
Upper angle Arsenal wall	5,230	26.8	8.54	.....	19,145	5,360	4,365	28,870	44,560	94,954	.....		41–42
Old wharf, Arsenal	7,852	25.1	7.48	.....	20,392	5,602	4,145	†30,139	58,484	96,068	.....		43–44
Lower Arsenal wall	6,774	21.5	7.01	8.4	18,225	5,777	3,580	†27,582	56,590	84,588	93,776		45–46

*Under bridge.

†Not including flats west of channel.

VELOCITY OBSERVATIONS.

The general method of taking the velocity observations was as follows:

All depths and velocities observed were those at times of maximum velocity.

The vertical sections at right angles to the axis of the stream were divided into parallelograms whose horizontal width was 100 feet, and whose height was the mean depth over each 100 feet at the line of maximum velocity.

The sum of the areas of these parallelograms was the area of the section of the river at that point. Then the joint mid-area was compnted through which a vertical plane parallel to the axis of the stream divided the area of the whole section into two equal parts. The points were plotted by means of the horizontal distances from the common origin of areas and velocities (viz, a point on the land or wharf near the shore line). The point of mid-area was computed for each section and the line of mid-areas drawn through them. The volumes passing through the area of each of the parallelograms at the time of maximum velocity was computed, and their sum is the total volume passing the section.

The point of mid-volume was computed through which a vertical plane parallel with the axis of the stream divides the volume into two equal parts. This point was plotted by means of its horizontal distance from the origin. The point of mid-volume was computed for each section, and the line of mid-volume is drawn through them.

Separate computation was made for flood and ebb.

The plots of flood and ebb current show some interesting results as to the effect of the tidal current upon the fluvial discharge of the river. From the Little Falls to a point near the Potomac Boat Club-house in Georgetown there are down-stream currents, and a *fluvial* discharge during the entire period of flood tide, so that the only effect of the flood-tidal current above Georgetown is to raise the surface of the water without causing any flood discharge. Plots of the flood and ebb currents accompany this report.

In the arrangement of the bulkhead lines or lines of filling, shown on this map, it has not been practicable, on account of economical considerations, to make them exactly concentric with the lines of mid-volume. The curvature of these lines will, however, be made more conformable by the alteration in the position of the cross-section of the present channel.

In making the calculations for the improvement of the river it was necessary to determine the low-water sectional area which should be adopted as a standard. The average sectional area of the river between the Aqueduct Bridge and Easby's Point was found to be 19,316 square feet, and for the Georgetown Channel between Easby's and the Long Bridge, 20,679 square feet. The sectional area at the Long Bridge was believed to present the conditions necessary for determining the area which should be assumed as the standard in the calculations for the improvement. In these calculations the heights of freshet assumed are those of the freshet of 1877, which was actually a higher freshet than that of 1881, the greater elevation of the latter above the Long Bridge being due to the ice gorges at that point as already stated.

The cross-section taken parallel with and 80 feet above the Long Bridge showed the sectional area of the Georgetown Channel to be 21,051 square feet (between the lines of the abutments); that of the Washington

Channel to be 4,662 square feet; and of the flats between, 1,826 square feet. The sectional area of the Washington and Georgetown channels together at this point is 25,713 square feet. From this point to the Arsenal wharf the average section of the two channels together is about 24,800 square feet, not including the flats between them.

As the Georgetown Channel will, upon the completion of the improvement, be called upon to discharge the entire body of the freshet water, its low-water section should be equal to the combined section of the two channels, and in view of all the facts ascertained by the survey the standard low-water section has been assumed at 25,000 square feet.

The sectional area of the freshet of 1877 has been assumed as the standard in providing for the freshet discharge. A sectional area of 48,000 square feet, with a rise of 10 feet, has been provided for at the Long Bridge. In order to discharge this through the Georgetown Channel it will be necessary to remove the causeway, which forms a part of the abutment of the southern end of the bridge for a distance of about 400 feet, replacing it by trestle-work (or spans of bridge similar to those now in use), the causeway to be removed to a depth of 3 feet at low-water, so as to allow the tide to flow underneath it. The sectional areas above and below the bridge will be sufficient for the discharge of the water of freshets.

	Square feet.
1. The low-tide sectional area assumed as a standard, is	25,000
2. The high-tide sectional area assumed as a standard, is	32,875
3. The freshet area assumed as a standard, is	48,000

The limits of the flats to be reclaimed, as contemplated in the act. by means of the dredged material, the port warden lines for the Washington Channel or inner harbor, as well as the outer port warden line beyond which neither wharves nor landing slips will extend, are indicated on the accompanying tracing. The harbor lines are not indicated precisely on the map, but will be fully laid down on later maps which embody the fuller results of the survey.

On the Georgetown Channel the harbor line commences at Easby's wharf, following a curved line as shown on the plan to the southerly end of the causeway of the Long Bridge, thence on a curve nearly parallel with the river channel to a point on the flats below the Arsenal wharf at the intersection of the two channels.

For the Washington Channel the inner line follows nearly the limits of existing wharves, and the outer line of the Washington Harbor is 800 feet from the inner line. The inner line, beyond which it is recommended that no wharves be allowed to extend, is as follows:

Commencing at a point 25 feet outside the northwest corner of Riggs's wharf, running thence in a straight line to a point 15 feet outside the southwest corner of the lower wharf of the Great Falls Ice Company, thence in a straight line to a point 25 feet outside the southwest corner of Evans's stone wharf; thence in a straight line to a point 25 feet outside the northwest corner of the third wharf below the Alexandria Ferry Company's slip; thence in a straight line to the southwest corner of the wharf of the Inland and Seaboard Company, and continuing to a point 140 feet above the first angle in the Arsenal wall and 220 feet west of said wall; thence to a point 130 feet outside the Arsenal wall at the site of the old penitentiary wharf; thence to a point 10 feet west of the northwest corner of the existing Arsenal wharf.

The Washington Channel above the Long Bridge is left open as far as Seventeenth street.

The greatest depth of the sectional area of discharge is assumed as

equal to the greatest depth of the proposed channel, the assumption being based on the observations of velocities of ebb and flood tide.

The part of the channel south of the reclaimed area being partly an estuary of Chesapeake Bay, may have a low-water sectional area greater than the low-water section of the river at that point, without any alteration of the present low-water surface of the river.

The tidal area excluded by the improvement will be about 695 acres. While the exclusion of tidal water in harbor improvements is not to be desired, in the present instance it cannot be avoided.

The increased depth of channel will, however, facilitate the propagation of the tidal wave, and will in some degree compensate for the exclusion of tidal water.

IMPROVEMENT.

The general plan of improvement consists in dredging the Georgetown Channel to a maximum depth of 25 feet, with a bottom width of *dredged* channel not less than 400 feet, so as to give a low-water area of 25,000 square feet; dredging the Washington Channel between the Long Bridge and the Arsenal wharf to a width of 400 feet at the bottom and a depth of 20 feet at low-water, and thence to the outer wall, where the depth will be 5 feet, the dredged material to be placed upon the flats, so as to raise them to a height of 6 feet above low-water; this area to be protected from freshets by means of an embankment around the edge of the reclaimed area, with a provision for drainage.

It may further be desirable to dredge out a basin above the Long Bridge and alongside of the present sewer canal to scour out this canal at low-water.

As the detail of this general plan of improvement may be varied somewhat, I have prepared the following estimates:

ESTIMATE NO. 1.

The dredged material to be deposited on the flats so as to raise them to a height of 6 feet above low-water, both above and below the Long Bridge. An embankment around the edge of the reclaimed area 50 feet wide on top, with outer slope of 1½ to 1, and inner slope 3 feet in 100 feet. Height 12 feet above low-water above bridge and 10 feet below bridge. The edge of the filling protected by a wall of dry rubble masonry.

8,940,210 cubic yards material dredged and deposited on flats, at 18 cents.	$1,609,238
366,020 cubic yards embankment, at 20 cents	73,204
500,000 cubic yards inner slope embankment, at 18 cents	90,000
Dry masonry wall	292,540
Contingencies, 10 per cent	206,498
Total	2,271,480

ESTIMATE NO. 2.

Height of filling 6 feet as above. Embankment along Virginia avenue from Eighteenth street to the high ground on the Monument Lot, to protect the city against floods, slope protection of riprap and piles.

8,940,210 cubic yards dredging, at 18 cents	$1,609,238
Embankment on Virginia avenue	10,740
Slope protection	99,552
Contingencies	171,953
Total	1,891,483

If the height of filling is made 5 feet, with embankments and slope protection, riprap, and piles, the cost would be $1,760,216.

Ponds for sluicing the sewer canal can be constructed without additional expense, except for gates for receiving the water at flood-tide and discharging it at ebb tide.

The area of 57 acres of the Washington Channel, between the Long Bridge and Seventeenth street, could be used for sluicing out the Washington Channel if the canal is not built. The dredging of this area to a depth of 10 feet is provided for in the estimate.

CANAL.

The estimate for a canal on the line indicated on the map connecting the Washington Channel with the Georgetown Channel is not included in the general estimate of the improvement.

As, however, some information may be desired as to the cost of the canal, I have prepared the following estimate for a canal 200 feet wide and 20 feet deep, as follows:

Dredging 1,234,370 cubic yards at 18 cents	$222,186
Side walls	186,000
Gates and gate chambers	73,000
Contingencies	48,119
Total	529,305

This canal can be constructed without interfering with the harbor lines proposed. Its construction would result in a saving of distance between the wharves of Washington and Georgetown of about 3 miles.

The disadvantage would be the increased cost of the work, and the fact that the sewerage from the sewer canal would be brought into the Washington Channel at a time when its presence would be very undesirable.

In the above estimate the amount of the dredging proposed equals that of the embankment; but if any additional material is required for filling, it can be taken from the vicinity of the Naval Observatory.

RECAPITULATION OF ESTIMATES.

The first estimate submitted for a filling 6 feet in height, with a dry rubble masonry wall and embankments, is the estimate recommended for the improvement, and amounts to $2,271,480.

The second estimate is a modification of the first by omitting the embankments and using a slope protection of riprap, and amounts to $1,891,483. While, if the filling is made 5 feet high, with the riprap slopes, the cost will be $1,760,216.

I, however, recommend the adoption of the first plan.

The price of dredging is taken at 18 cents per cubic yard on the assumption that at least $600,000 per year will be available for the work. If smaller appropriations are made, the cost per cubic yard, and therefore the total cost, must be increased accordingly.

METHOD OF EXECUTING THE WORK.

It is recommended that the work be done by contract in the usual manner, and that the work below the Long Bridge be executed first, so as to prevent the formation of ice-gorges and the consequent injury to property.

I respectfully recommend that an appropriation of $2,271,000 be made for the purpose of carrying out the improvement, at least $700,000 to be available annually.

The following maps and plans accompany this report:

1 general map, scale $\frac{1}{10000}$, showing proposed plan of improvement, harbor lines, channel, and area to be reclaimed.
1 map, on a scale of 400 feet to an inch, showing cross-section and line of mid-area and mid-volume.
9 cross sections of the river.
1 sheet of velocity observations of tidal current.
2 plans showing proposed wall and slope protection of riprap, &c.

Very respectfully, your obedient servant,

S. T. ABERT,
U. S. Civil Engineer.

THE CHIEF OF ENGINEERS, U. S. A.

PRELIMINARY REPORT OF BOARD OF ENGINEERS.

NEW YORK, *February* 18, 1882.

GENERAL: The Board of officers of the Corps of Engineers, convened by Special Orders No. 129, Headquarters Corps of Engineers, December 1, 1881, which was subsequently directed by Special Orders No. 11, January 26, 1882, from the same headquarters, "to consider and report upon the plans and estimates for the improvement of navigation of the Potomac River, in the vicinity of Washington, D. C., the raising of the flats in front of the city, and the establishment of the harbor lines," have the honor to submit the following preliminary report:

The Board received for its guidance the following letter of instruction:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 9, 1882.

SIR: The inclosed report and accompanying maps of Mr. S. T. Abert, United States civil engineer, upon the survey directed by section 3 of the river and harbor act of March 3, 1881, to be made of "Potomac and Anacostia rivers, in the vicinity of Washington, D. C., with reference to the improvement of navigation, the establishment of the harbor line, and the raising of the flats, so far as their improvement may be necessary to the improvement of navigation, and the establishment of the harbor-line," are transmitted for the information of the Board of Engineers, directed by Special Orders No. 11, Headquarters Corps of Engineers, current series, to assemble in this city, &c., of which you are the presiding officer. The Board will give the subject careful consideration, and if any additional information is required to a proper understanding of the questions involved, Mr. Abert will, upon its request, be directed to furnish the same, either by appearing before the Board in person or otherwise.

In view of the deep interest felt in regard to the improvement of the Potomac River by the Commissioners of the District of Columbia, as well as by the business community and the citizens generally, it would seem to be advisable that the Board request the attendance of Maj. W. J. Twining, Corps of Engineers, the Engineer Commissioner, with a view to obtaining such information upon the subject as he may desire or be willing to impart.

* * * * * * *

By command of Brigadier-General Wright:
Very respectfully, your obedient servant,

JOHN G. PARKE,
Lieut. Col. of Engineers, Brt. Maj. Gen., U. S. A.

Lieut. Col. Q. A. GILLMORE,
Corps of Engineers.

The Board had before it for consideration the following plans:

I. Those considered by the Board of Survey constituted by act of Congress approved March 5, 1872, designated plans A, B, and C in the

report of that Board printed as Senate Miscellaneous Document No. 15, of the Forty-second Congress, third session, and there described as follows:

A. To carry the main channel from the lower end of Analostan Island and across the flats above Long Bridge and below Easby's Point into the small channel running along the Washington front, at or near the intersection of the extensions of Seventeenth and C and D streets southwest, and thence continue along the present front of the city until it joins the deep channel of the river just below the arsenal.

B. To have two channels, forming the flats above and below Long Bridge into an island. The main deep channel to remain along the right bank of the river down to Gravelly Point (just below Long Bridge), and thence to the deep channel off Giesborough Point. The second and smaller channel to run from a point just below Easby's Point across the flats, with its upper edge just touching the end of the wharf at Seventeenth street west, and thence along the present Washington front until all the channels join the deep channel off Giesborough Point.

C. To have but one channel, of sufficient width and depth for all purposes; a direct continuation of the river at Georgetown, to run along the right bank of the river as far down as Gravelly Point and thence directly toward Giesborough Point on the left bank, joining the deep channel of the river at that point, following nearly the present main channel of the river.

The latter plan was recommended by the Board of Survey. Its cost was estimated at about $4,000,000.

In this plan (C) the edge of the channel on the Washington side was to be defined and limited by a line of bulkhead and piers constructed of wood artificially preserved, the bulkhead being a crib-work filled with stone, with its base 23 feet below low-water, resting on a foundation of piles and carried up to 6 feet above high-tide, which height was the general level of the front line of the reclaimed area. This plan involved the cutting of a large portion off Analostan Island, about 700 feet at the widest part, of about 450 feet width off Easby's Point, and of some 1,300 feet width off Gravelly Point. The Washington Channel was entirely obliterated, though a basin of about 3,300 feet in length and 500 feet in width was provided along the arsenal front, the navy-yard being proposed to be changed in location to that point. The channel and harbor were proposed to be 23 feet depth at low-tide for a distance of 1,000 feet outside the pier-heads, 19 feet depth for a further distance of 750 feet, and 15 feet depth beyond this. The total width of the channel increased from 1,000 feet below the Aqueduct Bridge to 2,700 feet at the crossing of the Long Bridge, inclusive of the piers. The location of the Long Bridge was proposed to be changed to this extent, that in crossing the channel it should be at right angles thereto.

II. Plans proposed by Mr. S. T. Abert, United States civil engineer, which in general outline may be thus described: From a short distance below Easby's Point the main or Georgetown Channel to be deepened by dredging down to the deep water off Giesborough Point, the material so removed to be deposited on the flats above and below the Long Bridge, cutting off all communication of water between the upper end of the Washington Channel and the Georgetown Channel above the Long Bridge. This deeper channel is to include the lines of mid-area and mid-volume, as shown on Mr. Abert's map and described at length in his report, but less curved in direction. The Washington Channel below the Long Bridge is to be retained and to be widened, and also deepened to 20 feet at low-water, the material removed therefrom to be deposited upon the flats. A basin about 33½ acres is provided above the Long Bridge, with a depth of 10 feet, for a wood harbor, &c., and for the smaller class of vessels.

The main channel in its dimensions of width and depth is so planned that the material necessary for the filling shall be provided from the ex-

cavation, and that the sectional areas below the levels of low-tide, high-tide, and a freshet level 10 feet above low-water shall not be less than 25,000, 32,875, and 48,000 square feet, respectively, for reasons set forth in full in his report to the Chief of Engineers, dated January 17, 1882.

The line bounding the area upon which the dredged material is to be deposited comes almost out to the edge of the deep channel just below Easby's Point, recedes therefrom till at two-thirds the distance to the Long Bridge it is 1,000 feet distant, then approaching thereto it comes nearly out to the edge of the deep channel at the lower end of the reclaimed area. This channel does not cut into either Analostan Island or Easby's Point, or into Gravelly Point except taking off about 400 feet of the point on which the causeway rests.

No change of the location of the Long Bridge is contemplated by this plan.

The harbor lines proposed are set forth in detail in Mr. Abert's report.

The reclaimed area projects about 3,000 feet below the arsenal, or Greenleaf's Point, towards Giesborough Point. The area of flats reclaimed is 694 acres. With this general outline as a basis, the plans presented by him vary in details. As to depth of the main channel, the alternate depths of 25 and 20 feet are presented, with a preference for the latter depth, widening on the bottom as it progresses down stream.

Different projects are presented for the details of the arrangements of the reclaimed area.

First, the area to be inclosed by a dry masonry wall resting on piles, retaining the deposited material, which is filled to the height of 6 feet above low-water (3 feet above ordinary high-tide). This wall forms the bulkhead line. This surface of 6 feet height above low-tide is to be inclosed by an embankment of such height as to exclude freshets, and placed at a distance of 50 feet from the bulkhead line. The area within the embankment is to be drained by pipe furnished with valves, to permit outflow but prevent inflow. The bulkhead will form the base from which the wharves and piers are to be constructed. Mr. Abert estimates the cost of this project at $2,271,480.

Second. The area to be filled to the general height of 6 feet above low-tide, as before, protected on the water side by a slope of riprap supported by a footing of stone, but without an embankment to exclude freshets, which would thus at intervals submerge this area. To assist in protecting the city against floods, an embankment is proposed from Eighteenth street to the Monument Lot.

This project Mr. Abert estimates to cost $1,891,483.

Mr. Abert's report and drawings suggest modifications of these two plans taken as bases.

It is also suggested by his report that a portion of the area above Long Bridge may be dredged to provide a basin from which to sluice out the Washington Channel, or ponds may be provided from which to sluice out the sewer canal from B street.

Some parties desire a channel or ship canal to be cut from the upper end of the retained Washington Channel to the main channel, that communication may be had between the harbors of Washington and Georgetown without making the long detour by way of Giesborough Point. Mr. Abert presents an estimate of the cost of this canal, though it forms no part of the plans presented by him.

III. Maj. W. J. Twining, Corps of Engineers, Engineer Commissioner of the District, at the request of the Board, presented a drawing embodying his views of a project. In horizontal projection it is very similar to the projects presented by Mr. Abert, the variation being chiefly

that of an area of ponds above the Long Bridge, to be used as sluicing basins for the purpose of changing the water in the Washington Channel. these ponds receiving water during flood tide from the main channel. and discharging on the ebb into the Washington Harbor.

Major Twining proposes raising the level of the reclaimed area to the height of 4 feet above freshet overflow, and proposes a riprap protection alone for the south side of the reclaimed area. He proposes a sectional area, below the freshet line, of 45,000 square feet. His project includes also the cutting of some 250 feet off Easby's Point. For the time he would keep the filling of the flats somewhat within the line of bulkhead proposed by Mr. Abert, until observation of the river could be made with its new regimen, and he would for the present limit the area of deposit below the Long Bridge to perhaps two-fifths of the contemplated project. His plan is also to build a catch sewer along the harbor front, so that none of the city drainage should vitiate the water of the harbor, this sewer to discharge into the Eastern Branch.

IV. Another plan for reclamation and improvement which has been considered is as follows:

Reclaim the areas which are proposed to be reclaimed in the plans of Major Twining and Mr. Abert; but instead of doing it by filling, use the methods adopted in Holland. Build a dike around the area to be reclaimed, which should inclose it on the water side, and on the land side should permit little or no rainfall drainage to enter. The top of the dike to be placed at 3 feet above the flood of 1877, which would make its greatest height 12 feet above high-tide. Its top width should be 20 feet, its slopes 1 on 4, and its river face should be riprapped.

The interior area would have a basin and would be thoroughly drained by small canals in which the level of the water would be kept 3 feet below the surface of the ground by pumps driven by steam-engines. The Seventeenth-street sewage canal in crossing the reclaimed area would have its banks diked to a height of 3 feet above the flood of 1877. The drainage of the reclaimed area north of this canal would cross the canal in a siphon. Washington Harbor would become an inclosed harbor, to be maintained by dredging, and into which no sewage should be allowed to enter. The dike along the south side of the flats would contract the Georgetown Channel, thus improving its navigation, and this improvement would be perfected by the dredging needed to procure materials for the dikes. The reclaimed land would be available for cultivation for parks, or for building purposes.

Taking the pumping-engines at 200 effective horse power, the cost of the necessary works of improvement and of the pumping-engines would be about $650,000, and there would be an annual expense for pumping of about $8,000.

This plan of improvement, when the reclaimed grounds are drained to a depth sufficient to make them as dry as ordinary uplands, secures the desired ends at the minimum expense.

But it would leave much of the reclaimed lands below low-tide, and hence less valuable for the purposes to which it may hereafter be applied.

This Board is of the opinion that an improvement which shall combine substantially and in its essential features the harbor and shore lines of Mr. Abert's plan from Easby's Point to the arsenal, and the low-grade filling and surrounding embankment of that plan below the Long Bridge, with a cheaper revetment than he proposes, with Major Twining's high-grade filling and sluicing-ponds between the Long Bridge and Easby's Point, offers a better solution of the various questions con-

nected with the improvement of navigation, the establishment of the harbor lines, and the reclamation of the flats, than any of the other projects or combination of projects that have been considered. It is regarded as necessary to the proper execution of this plan as thus defined that the channel depths in both Washington and Georgetown harbors should be sufficient to accommodate the largest draft that can be brought up to Arsenal Point, with such additional depth at the wharves that vessels can receive their full cargoes without grounding at low-water; that the filling over the flats above the Long Bridge, as well as the crest of the surrounding embankment below, should be carried up to a height of 3 feet above the flood-slope of 1877; that the flushing-ponds should not be less than 8 feet deep, and be provided with inlet and outlet gates of ample dimensions, automatically arranged, for filling the ponds from the Georgetown Channel to the level of high-water and emptying them into the Washington Channel to the level of low-water during each oscillation of the tide; that an ample system of drainage for the reclaimed areas be provided; that all sewage now discharging into the Washington Channel should be intercepted and conveyed away to the James Creek sewer canal east of the Arsenal; and that the Long Bridge shall be rebuilt, at an early period during the progress of the improvements, with wide spans upon piers offering the least possible obstruction to the flow of water.

The Board recommends the adoption of this plan of improvement, with such modifications of details, to be submitted in a future report, as a further study of the subject may suggest as advantageous or expedient.

It is estimated that the cost of the improvement as recommended will be about $2,500,000.

It is desirable that an appropriation of not less than $1,000,000 should be made in one sum.

The Board recognizes the principle that the area of the tidal compartment of a stream should be diminished as little as possible in any project designed solely or mainly for the improvement of the channel. In the case under consideration other interests than those connected with navigation are to be subserved, the reclamation of the flats, with the consequent reduction of the capacity of the tidal basin, being one of the leading objects to be attained. The mischief, if any shall ensue, from nonconformity to a well-established law, will not, it is thought, be serious, and it will be felt, if at all, below the Arsenal, and not at the site of the works.

The Board have had the opportunity to examine the interesting report of Col. George E. Waring, jr., to the officer in charge of the public buildings and grounds, dated November 26, 1881, concerning an examination made by the former of the sanitary condition of the Executive Mansion in August, 1881.

The report is hereunto appended.

ANACOSTIA RIVER.

The information before the Board is not sufficient to serve as a basis of a general plan for the improvement of the Anacostia. This is due to the want of money for the necessary surveys. The Board, therefore, makes no recommendation for the Anacostia other than for the dredging of a channel 20 feet deep at mean low-water, and 125 feet wide, through the shoals which now prevent proper access to the navy-yard, with the excavation of a turning basin of suitable capacity and 24 feet depth at the yard. The cost of such dredging will be about $50,000,

which is included in the aggregate of $2,500,000 previously given. This extent of improvement is understood to be all that is necessary at this time.

Accompanying this report are the following maps and documents:

Report of Mr. S. T. Abert to the Chief of Engineers, dated January 17, 1872, with its accompanying maps and drawings.

Extract from the report of the Commissioners District of Columbia, for the year ending June 30, 1879.

Letter of Major W. J. Twining, Corps of Engineers, Engineer Commissioner of the District, with map of the improvement proposed by him.

Report of George E. Waring, jr., on the improvement of the sanitary condition of the Executive Mansion.

Respectfully submitted.

Q. A. GILLMORE,
Lieut. Col. of Engineers, Bvt. Maj. Gen. U. S. A.
WM. P. CRAIGHILL,
Lieut. Col. of Engineers.
C. B. COMSTOCK,
Lieut. Col. of Engineers and Bvt. Brig. Gen. U. S. A.
THOMAS TURTLE,
Captain of Engineers, Recorder.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

POTOMAC RIVER FRONT.

[Extract from the Report of the Commissioners of the District of Columbia for the year ending June 30, 1879.]

The condition of the river frontage of the city demands the immediate and careful consideration of Congress, not only as a measure of health, but also with reference to the future commercial interests of the city. The gradual accretions of the flats have reached that point when it is necessary that some decisive action should be taken to abate what is rapidly becoming a gigantic and intolerable nuisance. Three plans have been proposed:

1st. To deflect the river around Easby's Point, and as nearly as possible along the Washington shore.

2d. To divide the river into two channels, one along the Washington and the other along the Virginia shore.

3d. To retain but one channel along the Virginia shore, and to fill from the present city to that line.

To the first of these plans three objections arise:

1st. The practical difficulty of forcing a river subject to violent floods into the desired position.

2d. That a large extent of malarial marsh will remain on the Virginia side, to be a perpetual nuisance to the city.

3d. From the curvature of the channel, the deep water for a long distance below Easby's Point will be upon the Virginia side and the shoal water for that distance along the city front, thus sacrificing what will in time be a valuable wharfage.

With reference to the harbor of Washington and the three plans above mentioned, the board of survey ordered by act of Congress approved March 5, 1872, reported as follows:

"1. The so-called harbor of Washington consists of merely an insignificant channel running along the Potomac front, from the Arsenal Point (formerly known as Greenleaf's Point, the upper point at the junction of the Anacostia with the Potomac), up to the end of the wharf at Seventeenth street, a distance of 4,000 yards, with also a small channel running along the Anacostia front.

"2. The Potomac Channel has an average width of 400 feet up to Maryland avenue, or Long Bridge, between the depths, on either side, of 6 feet at mean low-water, narrowing off the arsenal lower wharf to 250 feet. The greatest depth at mean low-water, which can be carried up through a small gulley in the channel to the lower wharves at Sixth street southwest, is 11 feet, and up to Maryland avenue 8 feet. From

the Long Bridge up, this channel, gradually narrowing, shoals, and becomes lost in the flats off Seventeenth-street wharf.

"3. The Anacostia Channel has an average width of but 350 feet between the depths of 6 feet on either side, narrowing at one point to 250 feet. The greatest depth at mean low-water which can be carried up through a small gulley in the channel to the navy-yard is 14 feet. That portion of the channel alone extending from the arsenal to the bridge just above the navy-yard is considered. This channel extends, however, up the Anacostia, gradually decreasing in depth until at a distance of one mile above the bridge it has a depth of but 6 feet.

"4. The harbor of Georgetown consists of a deep portion of the Potomac River lying between the front of the town on the left bank, and a small portion of the right bank, and Analostan Island, near the right bank. The Georgetown and Alexandria Canal crosses the river at the upper end of the town, 1,500 feet above Analostan Island, by an aqueduct, at a height of about 30 feet above mean high-water, supported on stone piers, which also support a bridge above the aqueduct. This harbor has an average width of 800 feet, with an average depth of 25 feet at mean low-water. But the greatest *natural* depth over the bar, in the main channel of the Potomac, just below this harbor, is but 10 feet at mean low-water. This depth has been increased by dredging, to 15 feet, with a width at the bottom of the channel of 200 feet.

"5. This main channel runs down from Georgetown Harbor, between Analostan Island and Easby's Point (the south end of Twenty-seventh street west), along the right bank of the river, as far as the southwest end of Long Bridge, and thence runs toward the lower point of the mouth of the Anacostia, called Giesborough Point, off which it joins the channel from the Anacostia and that from the Potomac front of Washington, and thence the three form the deep channel which continues down the river.

"The length of this channel, from the canal aqueduct to deep water off Giesborough Point, is 25,000 feet.

"6. Between the main channel of the Potomac leading from Geisborough Point to Georgetown Harbor, on its southwest and west sides, the small channel along the Washington front on the northeast and east sides, the shore lying between Seventeenth street west and Twenty-seventh street west (or Easby's Point) lies an immense marshy flat of over 1,000 acres in extent. One-third of this flat is a marshy land, out at low-water, with but 1 to 4 feet of water upon the remainder. This marsh land has accumulated with greater rapidity during the last twenty years, from the constantly increasing deposits of the materials brought down by the Potomac, as the country above is cleared of forests and put under cultivation.

"These materials find a natural place of deposit at this place, as the Potomac here changes entirely, from a narrow mountain stream to a broad, lake-like river, which character, with broad flats, having a deep channel through them, it retains until near its mouth.

"7. The deposits upon the flat referred to, in front of Washington, increase greatly every year, as do the marsh and water grasses which grow rankly on all parts of it, becoming annually more and more obnoxious in every way.

"The reclamation of this flat is an absolute necessity for the preservation of the health of the city, and must be included in any plan, aside from commercial purposes, for the improvement of the water-front of Washington.

"8. Three general plans only are reasonably feasible, but the details may be greatly varied. These general plans are—

"A. To carry the main channel from the lower end of Analostan Island across the flats above Long Bridge and below Easby's Point into the small channel running along the Washington front, at or near the intersection of the extensions of Seventeenth and C and D streets, southwest, and thence continuing along the present front of the city until it joins the deep channel of the river, just below the arsenal.

"B. To have two channels, forming the flats above and below Long Bridge into an island. The main deep channel to remain along the right bank of the river down to Gravelly Point (just below Long Bridge), and thence to the deep channel off Giesborough Point. The second and smaller channel to run from a point just below Easby's Point across the flats, with its upper edge touching the end of the wharf at Seventeenth street west, and thence along the present Washington front until all the channels join the deep channel of the river off Giesborough Point.

"C. To have but one channel of sufficient width and depth for all purposes; a direct continuation of the river at Georgetown, to run along the right bank of the river as far down as Gravelly Point, and thence directly towards Giesborough Point on the left bank, joining the deep channel of the river at that point, following nearly the present main channel of the river.

"9. The plan A does not reclaim the immense flat in front of the city, this reclamation being an absolute necessity for sanitary as well as commercial purposes. This flat would rapidly become an enormous marsh opposite the city, and upon that side from which the prevalent winds blow, especially in summer and autumn. The cost for

excavation in this plan would equal that in either of the other plans, and its cost for bulkhead would equal that of C, but would be less than that of plan B. The cost of filling up the remainder of the great marshy flats lying on the right of the channel thus made to the right bank (a filling necessary for sanitary reasons) would greatly exceed the cost of filling in either of the other plans, and these flats would be of comparatively no value when filled.

"The plan B reclaims and utilizes, as does plan C, the whole of the flat lying in front of the city, but forms it into an island. The cost of its filling and excavation does not differ greatly from that of plan C, but the cost of its bulkhead greatly exceeds that of the latter. It has the advantage of much greater frontage, viz: B, about, for both harbors, 58,500 feet, and C, about 37,000 feet, exclusive of piers, wharves, &c. These last, in B, could be nearly double those in C. In the plan B there would be a wide channel separating it from the city, involving a large additional cost for bridges; less land would be reclaimed, and none of it advantageously available for governmental uses. But it would afford greater advantages for the drainage and sewerage of a large part of the city.

"The plan C reclaims all the flats, and advances the city front directly to the edge of the harbor channel; affords abundant frontage, about 37,000 feet, exclusive of piers, wharves, &c.; is much less expensive, and gives about 455 acres of land most advantageously located for government purposes.

"10. This last plan, C, is the one adopted."

It is proposed to modify the plan of the board of 1872 in three particulars:

1st. By leaving the present inside or Washington Channel below the Long Bridge, providing suitable sluicing basins for the purpose of keeping the channel in proper sanitary condition.

2d. By reducing the width of the outer or Georgtown Channel to 2,000 feet.

3d. By changing somewhat the proposed distribution of the reclaimed lands in order to correspond to the above modifications.

The width of the main channel is determined as follows:

The low-water sections of the river give the following areas in square feet, viz:

At Long Bridge, H. R. Report No. 264, February 10, 1834	23,977
Section at arsenal (small area on marsh south of main channel omitted)	23,175
Sections at Long Bridge, west side	25,017
Sections at Long Bridge, east side	27,978
Mean	26,497

The obstruction in and about the piers of the Long Bridge makes the sections at that point only approximate. It may be assumed, however, that the mean of the three sections at and below the Long Bridge will give a fair approximation to the natural low-water channel-way of the river. The mean thus found is 24,549 square feet. With a channel-way of 2,000 feet the mean depth should be 12.27 feet. With this mean depth the extreme channel depth should be over 25 feet. The mean of the sections on the bridge for the present main channel is 21,356 feet; the width is about 2,000 feet, or, deducting one-twentieth for piers and obstructions, 1,900 feet. The mean depth is 11.24 feet, and the extreme depth about 26 feet.

The sectional area of the proposed channel at the Long Bridge, assuming a rise at that point of 9 feet above mean low water, will be 41,646 feet; the present area is 44,134 feet. It will be necessary then to take out the causeway now existing at the south end of the bridge, 219 feet in length, to the low-water mark. This will increase the area to 43,617 feet.

During the freshet of 1877 the rise at Easby's Point was 14 feet; at Seventeenth street, 10 feet; at the Long Bridge, 9 feet, and at the arsenal 8.4 feet above low water. The relation between these different points shows that the Long Bridge presented no obstruction to the free passage of the waters. As a measure of safety it might be well to carry the bridge, in trestle, for a distance sufficient to give a total high-water sectional area of 45,000 feet.

The river at Easby's Point is reduced to a low-water section of 18,900 feet, added to which the configuration of the shore is such as to throw the current of the main channel strongly against the Virginia side, and to form a broad morass under the lea of the point. It is extremely important that all the wharfage line down to Seventeenth street should be preserved, and that there should be a uniform depth along the whole of this frontage. The channel should therefore be opened by cutting off the point, and giving it an area as great as it can probably maintain; that is, about 24,000 feet. If the depth along the bulkhead is assumed to be 23 feet, there will be 222 feet to be cut from the point. The excavation will be mostly in rock, but the greater part in open cutting. It seems most probable that the point of Analostan Island should also be removed to the depth of about 6 feet below low water, in order to throw the main channel more easily against the proposed line of the Washington shore. This is, however, a matter of no pressing importance, since the direction

of the main channel may be controlled by a retaining wall, composed of rough stone, carried down from the island in the position indicated. The channel at this point should be about 1,500 feet in width. With a rise of 10 feet in time of flood, the sectional area would be 39,000. The channel-way back of Analostan Island, or the section of the river, should then be opened to such a width as to give about 5,000 feet additional area. By this means the flood line along the Georgetown wharves would be lowered about 3 feet. It would seem better, if possible, to avoid opening the Analostan chute on account of disturbing the regimen of the river below. This might be done by cutting the channel to a somewhat greater width at the head of the island. This, however, is a matter which may be left for future consideration. We may say with certainty that the bar in the Georgetown channel will disappear when the works here outlined shall have been completed.

The inside channel, being stopped at the Long Bridge, will become an inside basin. With such an arrangement proper means must be taken to keep the water in a pure and wholesome condition. To accomplish this end flushing or sluicing basins are to be provided on the present flats above the bridge, into which the water from the outer channel may be admitted at high tide by automatic gates. The waters so accumulated will be used to flush the inner channel on the last third of the ebb tide. The total area of these basins is 100 acres. As the mean rise of the tide is 3 feet, the quantity of pure water passing from them into the inner channel with each tide will be about 14,000,000 of cubic feet. The entire contents of a channel-way 500 feet wide, with a mean depth of 12 feet, will be 54,000,000 cubic feet. The inflowing tides will supply 27,000,000, while the flushing basins will supply 28,000,000. Thus the water will be entirely displaced each day. For a channel of greater dimensions larger basins may be provided below the present causeway.

With this general scheme the flats to be reclaimed form themselves into three natural divisions: 1st. The portion lying below Easby's Point and above Seventeenth street; 2d. The area between Seventeenth street and the causeway of the Long Bridge; 3d. The flat extending from the Long Bridge to the Arsenal Point, and included between the two proposed channels.

Each of these divisions will require a different treatment. The immediate object to be attained is to put the flats in such condition that they will no longer be the source of malarial disease. With this great end in view, a bulkhead line should be carried from Easby's Point to the Long Bridge. The area above Seventeenth street and within the bulkhead should be filled to a height of one foot above mean high tide, and drained by automatic tidal gates in the manner usually practiced in the reclamation of other tidal marshes. It would then remain in the condition of a meadow until by the growth of the city it is required for business purposes.

The portion lying below Seventeenth street and above the Long Bridge should be filled to extreme high water, and added to the public parkings, thereby securing to these grounds a river frontage, and including the open lake and ornamental ponds which form the sluicing basins for the inside channel.

The reclaimed lands below the Long Bridge should be filled to the height of two feet above ordinary high tide, forming meadows which would only be overflowed at long intervals during extreme high water. In this condition they might remain until required for business purposes.

The inside channel should be bulkheaded on the Washington shore, and along the flats simply secured by a slight embankment with a footing of rough stones.

The main embankment extending from Easby's Point to the Long Bridge should be secured by a footing of rough stone and riprap. The present width has been taken at 50 feet for the purpose of forming a driveway along the river front.

The system of sewers emptying at Seventeenth street should be carried out to deep water through an open canal 9 feet in depth, with revetted banks to prevent the lodgment of sewage at low tide. The total area of lands reclaimed will be about 630 acres, of which one-third will be thrown into the public parkings.

On revising the above there are certain modifications which I would now recommend. As originally proposed the portion of the flats lying above Seventeenth street and Easby's Point, and included between the present shore line and the Virginia channel, was to be raised to the height of high tide and drained as a tidal marsh. It would seem, however, that as this land would have an immediate marketable value, probably exceeding the cost of the reclamation, it would be advisable to fill to its full height of four feet above the flood line, and thus bring the property at once into market.

Under this supposition the entire cost of the fill above the Long Bridge, which, excluding the area to be occupied by the ponds, will be about 214 acres, would be $856,000. To this must be added the cost of the sluiceways at the head of the inside channel, $40,000; at the outer channel, $30,000; and at the canal, $10,000; also for riprap on the outer channel, $40,500; and for the interior lake, $10,000; giving a

grand total of $986,500. Adding ten per cent. for contingencies the total cost of the improvement above the Long Bridge will be $1,085,150.

Below the Long Bridge the expenditure may be regulated by the future demands of the city.

At the present time, as the flat is not out of water for its whole extent, even at extreme low tide, a fill of one-half of the total area would be sufficient and could be executed for $610,000, or, adding $36,000 for riprap, $664,000.

The cost of the cutting at Easby's Point is estimated as follows:

80,000 cubic yards, at $4.50	$360,000
27,000 cubic yards, at $1.50	40,500
36,000 earth excavation, at 20 cents	7,200
Total	407,700

The cutting on Analostan Island is not essential to our present purposes and may be left for future consideration. The ultimate cost would not exceed $110,000.

It is to be observed that the question of navigation is so intimately allied with the sanitary problem that they must be considered as one.

In presenting the subject for the consideration of Congress four questions arise, viz: 1st. Is this a work which should be executed at the present time? 2d. Is it advisable to have the work done as a public or private enterprise? 3d. If executed as a public work, may the methods be left to the discretion of a board of engineers; and, if so, what should be the constitution of that board? 4th. What disposition should be made of the various undefined rights which are now vaguely claimed by various individuals and companies?

W. J. TWINING,
Major of Engineers.

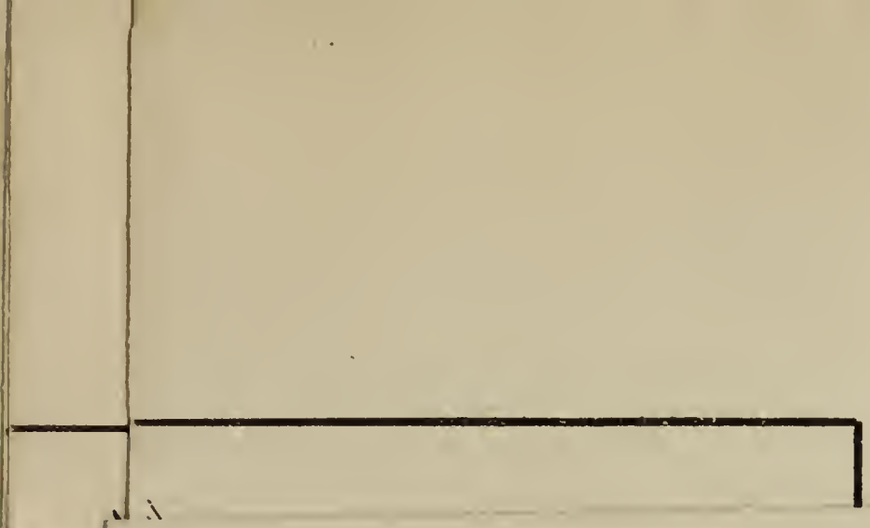
	Acres.
Area above Long Bridge between present shore line and proposed bulkhead	323.9
To pier heads	380.4
Area below Long Bridge—	
To bulkhead line	305.9
To pier heads	363.7
Area above Long Bridge, between continuation of Washington Channel and bulkhead line	86.4
To pier heads	110.5
Between continuation of Washington Channel and present shore line to bulkhead	164.0
To pier heads	196.4
Between Easby's Point and Seventeenth-street canal	104.6

LETTER OF MAJOR WILLIAM J. TWINING, CORPS OF ENGINEERS, ENGINEER COMMISSIONER OF THE DISTRICT OF COLUMBIA.

ENGINEER DEPARTMENT, DISTRICT OF COLUMBIA,
Washington, February 16, 1882.

SIR: In reply to the letter of the Board of the 12th instant requesting me to present in writing such modifications as I now think should be made in the plan proposed by me in the annual report of the Commissioners of the District of Columbia for the year of 1879, and requesting estimates of cost, I have the honor to state that so far as the general plan of the reclamation and the treatment of the river channel and inner harbor are concerned, I see no reason to recommend any change.

It is not necessary to say that the method of determining the proper width of the main channel was somewhat crude, by reason of the lack of time and data, but the very important fact that no perceptible change had taken place in the area of the low-water section of the river and no essential change in the relative dimensions of the Washington and Virginia channels were sufficiently established. The later surveys of course afforded more accurate results, but show that the low-water section assumed was very nearly correct.



No 1

HARBORS OF WASHINGTON AND GEORGETOWN. D.C.

Map showing

PROPOSED IMPROVEMENT.

To accompany report of
S. T. Abert, U.S. Civ. Engineer
Jan 17, 1882

SCALE:

0 200 400 800 1200 2000 3000 4000 6000 feet

GEORGETOWN

PENNA AVE

K ST

M ST

VIRGINIA AVE

NEW YORK AVE

14TH AVE

NATIONAL OBSERVATORY

WASHINGTON MONUMENT

B Street Canal

ANALOSTAN ISLAND

AREA RECLAIMED ABOVE BRIDGE 364 ACRES

Proposed Ship Canal

SYCAMORE PT

LIMIT OF DREDGING

LINE OF WHARVES

BULKHEAD LINE

AREA RECLAIMED BELOW BRIDGE 330 ACRES

GRAVELLY POINT

WASHINGTON

VIRGINIA AVE

DELAWARE AVE

N JERSEY AVE

S CAPITOL ST

U.S. ARSENAL

GREENLEAFS

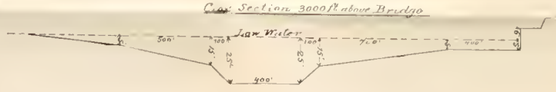
U.S. NAVY YARD

ANACOSTIA BRIDGE

GIESBORO POINT

Cross Section at Bridge.

Cross Section 3000 ft above Bridge.



SEN. EX. DOC. No. 126, 1st SESS., 47th CONG.

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MAP

OF THE

CITY OF WASHINGTON

Showing the plan for the Reclamation of the Marshes on the Potomac River front.

Proposed by
W. J. Twining,
Major of Engineers
Engr Commissioner DC

Described in the annual report of the Commissioners DC for the year ending June 30th 1879

Forwarded to the Board of Engineers, Feb 28th 1882
W. J. Twining
Major of Engineers

SCALE

SEN. EX. DOC. No. 126, 1st SESS., 47th CONG.

In the recommendation made upon page 5 [page 16 of this document] in regard to the removal of Easby's Point, I am inclined to think that it is not necessary to cut to a depth of more than 17 feet, and that the amount thus saved, which would probably equal one-third of the cost of the total cutting, might be more advantageously applied to the removal of the rocky point on Analostan Island to a depth of 6 feet below low-water, this depth being assumed simply as one which would be sufficient to prevent the growth of aquatic plants. The question of cutting away these points requires a more careful preliminary examination and survey than has yet been made before any accurate estimates can be given. My estimate of $407,700, upon page 9 [page 18 of this document], was based upon very partial measurements and soundings.

In no case should the Analostan Chute be disturbed before the effect of the operations upon the island and of Easby's Point shall have been determined.

The recommendation upon page 6 [page 17 of this document] in regard to the dimension of the inner harbor and the uses of the sluicing basins above the bridge were based upon the idea that an actual flushing effect could be obtained in addition to the simple and obvious purpose of purification. I am of the opinion now that the width of the harbor can be increased to any required dimension, say 800 feet, and that the supply of water from the sluicing basins will still be ample to insure a perfect sanitary condition.

Under the conditions of this harbor there will be little or no deposit, and any depth which may be once obtained by dredging will be maintained for many years.

On page 7 [page 17 of this document] a recommendation is made looking to the partial filling of the area above the canal at Seventeenth street, and lying below Easby's Point. I am now disposed to recommend the complete filling of this area, since it would immediately assume a value which would readily repay the expenditure.

I have carefully examined the estimate on page 8 [pages 17 and 18 of this document] for the reclamation of the area above the Long Bridge. The estimate allows $4,400 per acre for filling. Assuming an average fill of 4 cubic yards to each surface yard, the allowance amounts to 23 cents per cubic yard, which I think is sufficiently large. The estimates for sluiceways are also ample. I therefore see no reason to change the amount of the total estimate for the improvement above the bridge. It is to be understood that the estimates apply only to the reclamation of the portion lying within the harbor line, shown upon my map as submitted to the Board; and if the included area should be increased by throwing the line farther out, a corresponding allowance should be made.

It may be proper to present to the Board my views as to the order of events in carrying out the details of the plan, if it should be adopted.

The filling above the Seventeenth street canal should be begun with material taken from the main channel, the bulkhead line being carried down as far as Seventeenth street. Simultaneously the outer and inner sluiceways should be begun, and when completed they should be connected by a canal occupying a part of the area to be covered by the ponds, and having as large a reservoir capacity as can be given it. The bulkhead line should then be carried to the bridge and the lower lake excavated, the drainage of the remaining area being effected through the Seventeenth street canal. After the lower lake has been completed, the permanent connection between the sluiceways and the lake should be established. The second lake can then be dredged, and its connection made with the one already in operation.

The object of the method here recommended is to prevent the inner harbor from being filled with the sediment which will be stirred up in the process of dredging above.

Very respectfully, your obedient servant,

W. J. TWINING,
Major of Engineers,
Engineer Commissioner, District of Columbia.

General Q. A. GILLMORE,
President of Board of Engineers,
Harbor of Washington, D. C.

REPORT OF MR. GEORGE E. WARING, JR., ON THE IMPROVEMENT OF THE SANITARY CONDITION OF THE EXECUTIVE MANSION.

NEWPORT, R. I., *November* 26, 1881.

SIR: On the 18th of August I made as careful an examination of the interior sanitary condition of the Executive Mansion as was possible under the circumstances. As the floors and walls could not then be disturbed, I was obliged to depend on an inspection of such parts of the work as were in sight, and on the description given by the custodian as to the character of the concealed portions. From my preliminary report I extract the following:

"This examination indicates a very much less unsafe condition than current reports would lead one to expect. So far as exposed to view the workmanship of the plumbing within the house seems to be reasonably good. The arrangement of the various soil-pipes and waste-pipes is such as is usual where the construction has been added to from time to time as occasion required and as different plumbers suggested. Much of it is defective, not a little of it radically so. Considered as a whole, while they are free from some defects often found in the better class of houses in our cities, the plumbing appliances of the Executive Mansion do not conform to what are now accepted as the necessary sanitary requirements of a safe dwelling.

"Without stopping to describe in this brief preliminary report the details of the work examined, it may be useful to say that not one of the soil-pipes has anything like proper ventilation, and that more than one of them has no attempt at ventilation whatever; that the tank from which the upper part of the house is supplied with water is subject to direct contamination from the main soil-pipe and from the ventilator of an interior water closet; that one of the most important water-closets in the house is a pan-closet; that two of the water-closet compartments, one of which contains a urinal, are practically without ventilation.

"Your instructions confine my duty at this time to the recommendation of such changes as are of prime importance, postponing to my later and complete report on the general sanitary condition of the whole establishment all details which may, with reasonable safety, be deferred until it can be known what action Congress may take on the very important question of providing proper quarters for the residence of the President and his family, and proper offices for his staff.

"I therefore disregard for the present nearly everything relating to the exterior drainage, as of the area by which the house is surrounded, and much of the interior work which should receive attention when any radical change is made.

"Concerning alterations which it is now essential to make, some of the recommendations are of a somewhat makeshift character, the intention being to do only really essential work, and to avoid for the present as much expense as possible. With this view and under these limitations, I advise that the following work be done as soon as possible. I describe the existing conditions which require immediate modification:

"On the first floor of the house (the basement) there is a servants' bath-room, containing a bath and water-closet delivering into a horizontal 6-inch pipe which connects with the outer drain at a point at which there is no means for flushing, and which has no ventilation of any sort. The soil-pipe is too large for proper cleansing by the amount of flow which it receives.

"The sink in the large kitchen adjoining has a trap of such size as to constitute a permanent cesspool, accumulating organic matters and retaining them until decomposed; the same is true of the sink of the family kitchen, while an abandoned grease-trap on the course of the outlet of this sink is a constant source of accumulation.

"Off the landing of the service staircase between the second and third floors there is an unventilated compartment containing a water-closet of improper construction and in bad condition, together with an objectionable urinal.

"On the third floor, adjoining the same staircase, and over the water-closet just described, there is a water-closet of similar construction and not in good condition. Its outlet is through a 6-inch soil-pipe, delivering at right angles into the 10-inch pipe described below, and having no upward ventilation. The ventilation of this *apartment* is through open blind work in its ceiling, connecting its atmosphere with that of the room above, which is occupied by the main water-supply tank.

"Adjoining and also opening off the staircase there is a slop-sink, trapped by a common **S** trap, and delivering independently into the 10-inch pipe. Over this sink there opens an apparently abandoned large waste-pipe.

"Adjoining the staircase hall is the family bath-room, which contains two compartments, separated from each other and from the rest of the room by partitions not extending to the ceiling. The first of these contains a bath-tub and wash-bowl and a water-closet. The second compartment contains a bath-tub only. Both bath-tubs and the wash-bowl are reported to deliver by a 2-inch waste-pipe into the 10-inch pipe referred to above. The water-closet delivers through a 4-inch soil-pipe, which is trapped just before its connection with the 10-inch pipe. This 4-inch pipe is extended up through the roof with the intention of ventilating it, but the ventilation has never been made effective by the admission of air at its lower end, without which no real ventilation is possible.

"Adjoining the same staircase on the next landing, and immediately over the water-closet and slop-sink of the third floor, is a room containing an 1,800-gallon supply tank, to which water is forced by a pump in the basement, the pressure of the public water supply being insufficient to keep it filled. The apartment in which this tank stands is practically a water-closet, inasmuch as it receives through an opening in its floor the only ventilation of the closet below. In addition to this the tank is connected by a large overflow pipe with a 10-inch pipe receiving all of the water-closets, bath-tubs, and sinks above described, except the sink in the family kitchen. The free discharge of the filth thus delivered is prevented by one or more traps in the course of the sewer to which the 10-inch pipe leads. The pipe itself is ventilated in no adequate manner. As it receives the water of the entire roof, it must be thoroughly cleansed at each heavy rainfall, but during the intervals between considerable storms it must be the seat of very considerable foul organic decomposition. The end of the overflow pipe which extends into the tank has a very slight water seal, which is of some service when filled, but it is doubtful whether it frequently receives water, and its seal must be soon broken by evaporation. It is also subject to being emptied by 'siphonage' whenever much roof water is delivered to the large pipe.

"In the southwest room of the house, the room adjoining that in which the President lies, and approached only from that room, an apartment has been cut off, by a wooden partition, which contains a bath-tub and wash-bowl and a water-closet (a pan closet). This water-closet delivers into a soil-pipe which runs horizontally for some distance and then passes along the west wall of the house to the basement floor, where it turns to the west and connects with the sewer outside of the house. This pipe stops at the water-closet, having no upward extension or ventilation of any kind.*

"The wash-bowl has an independent trap, and it and the bath-tub deliver into an independent 2-inch waste, which enters the 4-inch soil-pipe near the ground, having there another trap above a Y branch of the soil-pipe.

"Under the conservatory is a water-closet apartment for the general use of the male attendants and officers of the mansion. Its whole condition is extremely bad, and, although it is well removed from the main house, its existence in its present state in connection with any government establishment should not be permitted."

In accordance with the recommendations then made the following work has been done:

The sink in the large kitchen, the three water-closets, the two bath-tubs, the wash-bowl, the urinal, and the slop-hopper connected with the 10-inch soil-pipe have been severed therefrom, and the saddle-hubs with which the connection was made have been replaced by bolting on tight caps, so that all foul drainage is removed from this pipe, and it now serves only to carry the roof water and the overflow of the tank to the brick sewer which passes under the boiler room and delivers through the grounds to the south, and as an overflow for the main tank. The sewer above referred to was found on examination to be in much less satisfactory condition than had been supposed. Its invert was laid without mortar, or the mortar has become washed out during use. What was much more serious was the fact that the branch sewer delivering into it from the north, supposed to be of small size and to have been cut off close to it, was of the full size of the main sewer, and was cut off some distance to the north, so that the full discharge of the 10-inch pipe set back into this branch, which had no means for flushing, and there formed considerable deposits of the foulest character. It must for a long time have been the seat of a decomposition which found no vent ex-

* Subsequent examination showed this soil-pipe not to run so directly as was supposed to the outer drain, but to follow a circuitous nearly horizontal course around the front of a large chimney, an arrangement which materially added to its defects.

cept through its imperfect walls and through the 10-inch pipe opening into the tank and in the attic of the building. This branch has now been entirely cut off.

The 6-inch pipe carrying the drainage of the servants' bath-room to the 6-inch pipe sewer outside of the house has been removed. A heavy 4-inch pipe, enameled inside and out, has been carried from the 12-inch pipe sewer under the north area at a point where there is a strong flow from the fountain, passing through the foundation wall and up beside the 10-inch pipe above referred to, and through the roof of the house, with a trap and fresh-air inlet at its lower end and an open mouth at its upper end. This soil-pipe receives the servants' water-closet and bath-tub, the sink of the kitchen adjoining, the private secretary's water-closet, the two water-closets, two bath-tubs, and one wash-bowl in the family bath-room, and one water-closet adjoining the President's apartments. The urinal has been removed from the private secretary's water-closet apartment, the closet being arranged to serve also as a urinal. The slop-sink near the family bath-room has been removed, as was recommended. More complete ventilation has been given to the different apartments in which plumbing appliances are retained.

The water-closet in the southwest room has been replaced, and its soil-pipe has been carried up through the roof for ventilation, and by the most direct course down to the drain outside the house. The outlets of the bath and the wash-bowl have been reconstructed.

The outlet of the sink of the family kitchen has been reconstructed, and its masonwork grease-trap has been removed. Both kitchen sinks have been provided with grease-traps immediately beneath them (Carson's), and a serious source of annoyance has thus been obviated.

The water-closets introduced (Dececo) have no moving parts whatever. They are made of white earthenware, and hold water to a depth of about 9 inches (sealing depth about 6 inches), the water being held to this level by the overflow point of their siphon outlet. By a special construction of the branch by which the foot of the outlet is connected with the soil-pipe, the rapid delivery into the closet of a single gallon of water causes this outlet to act as a siphon, and to withdraw the entire contents of the bowl, the amount delivered being 2½ gallons. The flood continues after all foul matters are removed, and the bowl is filled with clean water. Its lowest point is in full sight, so that any retention of fœcal matter must be detected at once. The bowl is set in white tiles, which cover the floor, sides, and back of the space under the seat. There is no riser in front of the bowl, and the seat is a well-finished hard-wood board, with no cover, hinged to be turned aside when the bowl is to be used for a urinal or slop-hopper. The whole apparatus is in full view and open to the freest ventilation, thus obviating the foul condition which it is the office of the carpentry of ordinary water-closets to conceal. Water is furnished to the bowl by a new form of flushing cistern (Bean's), which has a rapid discharge, and which, being once set in operation, continues to flow automatically until it is emptied, when it sets itself for the next discharge. During the filling of this cistern, a valve, moved by the arm of the ball-cock, delivers the small flow needed to refill the bowl of the closet.

The plumbing work has been done in a most satisfactory manner by Messrs. Hayward & Hutchinson, of Washington, under the constant supervision of my assistant, Mr. Chapman.

The closet under the conservatory is now being reconstructed.

It was not thought worth while at present to make any change in the laundry, nor, until it shall be determined what general improvements are to be made in the Executive residence, to do some much-needed work at the east end of the building. It will be easy at any time to introduce special lavatory arrangements at or near the east end of the upper hall. This addition to the drainage appliances is not an immediate necessity, but should it be determined to continue the present use of the existing offices of the upper floor, such a lavatory would certainly be a great convenience.

Pending any proposed alterations, the work now completed and in hand will probably be regarded as sufficient; but if the Executive Mansion is to be retained for its present use and substantially as it is, then there should be a complete overhauling of all the sewers under the outer areas and under the interior hallways. Indeed, if the building is to remain for any use, as I venture to hope that it may be, I recommend two very radical changes in its character:

1st. The entire abandonment of the basement of the building as living rooms for servants, and the conversion of the large commodious attic into dormitories. This attic affords abundant space for this purpose, and needs only efficient lighting and ventilation. These may be secured by the construction of ample dormer windows facing the south, which would be entirely concealed from view by the parapet balustrade. This change involves the construction of a service staircase to the attic. The introduction of an elevator has not only compelled the removal of the old staircase, but has become the only means of access to the private secretary's water-closet.

2d. The house stands near the summit of a gently-sloping hill, of which the soil is of an extremely porous character. It is beyond question that from the leakage of the

fountain basin, and of the water-pipes, drains, and sewers by which the house is surrounded, the soil under the building is in a state of more or less complete saturation—a saturation not entirely due to clean water.

Some of the outer drains, and especially the main sewer under the center of the building, have been leaking foul matters for many years. This heavy saturated soil bears not only the foundation walls of the building, but the very floor itself of the basement story. There is no manner of subventilation or adequate separation between the building and the ground. I recommend as a most important sanitary measure that the whole structure be supported on piers and groined arches of the best construction, to secure a complete separation between the ground and the building. It would be an advantage if this construction could be extended to include the areas at the north side and at the ends of the house.

In any reconstruction of the present building, with a view to its use as a residence or for offices, an entire rearrangement of its drainage work is to be recommended; the location and arrangement of the present plumbing appliances not being in accordance with the best practice of modern times, only the best that under the circumstances was easily practicable.

Aside from the sanitary state of the Executive Mansion itself, and of its immediate drainage work, the problem is complicated by external conditions of which the very serious character has long been recognized. These external causes of insalubrity affecting not only this building, but more or less all that part of Washington which has the same exposure, is due to two or three well-marked defects.

The most glaring and perhaps the most important is the condition of the "Kidwell Flats," not far from 1,000 acres of the silty deposit of the Potomac, which is nearly or quite exposed at low-tide, which bears in parts a rich aquatic vegetation, and which is a lodging ground for the sewage and other matters with which the water of the Potomac is fouled.

The second is the low and saturated condition of much of the city lying south of Pennsylvania avenue and the lower part of the hill on which the Executive Mansion stands. The flatter part of this land was formerly a low swamp which has been very imperfectly reclaimed by filling.

The third defect is to be sought in the fact that the natural drainage of the higher parts of Washington, which formerly flowed as clean water to the swamp that penetrated the site of the city and to the Potomac River, has, with the growth of population, become converted into a flow of foul sewage, more or less diluted according to the prevalence or absence of rain.

It is impossible to consider the whole problem of the improvement of the Executive residence without including these important factors. In other words, it becomes necessary to consider the general sanitary condition of all that part of Washington which is exposed to the same influences.

The problem presented is of too great magnitude to be fully treated in a special report of this character. In view of the careful discussion and study that it must receive before its proper solution can be determined, it will suffice here to refer very briefly to a few features of the case which seem to have been inadequately treated hitherto.

Absolute knowledge is wanting to justify the statement that the condition of the Kidwell Flats is the source of any malaria that may afflict those living subject to the prevailing winds which blow from them. The weight of evidence would, perhaps, indicate that as these shoals of the Potomac are covered at each tide, even their highest portions not being exposed to the air for more than a few hours at a time, they are not chargeable, under any generally accepted theory, with the production of intermittent fever. At the same time it would be unwise to disregard the possible serious influence of such decomposition as may there take place during the short periods of exposure. That the emanations from these flats are foul and offensive is notorious, and that their condition, whether absolutely injurious to health or not, should be regarded as intolerable, no argument is needed to prove.

The accepted theories as to the causation of intermittent fevers (malaria) point to conditions such as those of the low shores of the Potomac, and of those areas where the original swamp has been filled in only to a sufficient depth to afford safe building ground, much more directly than to that of any ground lying materially below the level of high water. The conditions which are supposed to be most favorable to the production of malaria are to be sought in connection with a constant or nearly constant saturation of the soil at a depth to which atmospheric air penetrates and circulates, and which feels a certain influence of the sun's heat. The depth of this point below the surface, or, in other words, the amount of filling necessary for a protection against these conditions, must depend upon the character of the filling, upon the movement of the tides, upon the facility of the lateral flow of ground water, and upon the intensity of the sun's heat. It would be impossible to define these conditions in any given case, even were it possible to say that the theories on the subject are reliable. Under the circumstances, it is most prudent to be guided by the general belief of those

who have studied what are regarded as malarious influences, and to obviate those influences on suspicion. Such a course would indicate the abatement of the Kidwell Flats, and still more strongly the abatement of the present saturated condition which marks much of the lower part of the city of Washington, especially in the district now under consideration.

While we are substantially ignorant on the subject of malaria, we are not more positive as to the influence of organic filth as an added factor in such cases as we are considering. Here also we can do little more than be guided by our suspicions, and to accept as a safe guide the instinct which leads us to avoid all such contamination. In other words, the prudent course would be to pay little attention to theories, and to accept as a common-sense guide of action the rule that all land in or near a town should be kept clean and dry; that it should be dried to such a depth as to prevent noticeably damp exhalations from it; and that its cleanliness should be absolute. If we adopt this standard as to what should be done in Washington, we shall see that something very much more radical is necessary than has yet been contemplated.

There is no doubt that if the Potomac Flats were filled to the height of the lower parts of Washington quite out to the bulkhead line proposed by the Board of Survey of 1872, it would afford valuable building ground or pleasure ground, and would remove a palpable nuisance of the most marked character. On the other hand, it would reproduce over a large area which is now covered constantly or mainly by the water of the Potomac the defective sanitary conditions which prevail throughout the old swamp area of the present city, and it would be open to the very serious objection that whereas the present lower parts of the city have a sort of feeble drainage to tide level, this means of exit would be much impeded by the removal of the shore line, making the portions of the city now occupied less salubrious than they now are. Furthermore, the difficulty which is now experienced in getting the foul sewage out of the city to the present river shore over the very flat grades existing would be increased by the great further extension of the tide-locked channels, so that in addition to an extension and an intensifying of the malarious area, there would be a great extension and intensifying of the filth-bearing area.

Having a high regard for the opinions of the distinguished engineers who have concurred in recommending the reclamation of the flats by filling, I have tried to reconcile their recommendations with what seemed to be the unmistakable teachings of sanitary experience. I firmly believe that their project would be, so far as the public health is concerned, a failure, and that the condition of Washington after the improvement would be worse than it is now.

The same consideration of the subject has led to the conviction that the desired result is to be attained only by the adoption of a diametrically opposite method of treatment, the end sought in both cases being the same, the drying and cleansing of the soil.

A reference to the practice of Holland in the reclamation of low or submerged lands, whether for cultivation or for residence, indicates the process which seems best suited to meet the conditions of the case in hand. But a much more pertinent reference, as a matter of argument, would be to that great area of the Surrey side of London, which has been built on the Thames marshes and upon flats formerly invaded by the river at every tide, where, by a similar process of embankment, the river floods have been excluded, and where the drainage of the whole vast area is constantly lifted by a series of steam pumps to a height of nearly 50 feet.

So long as the pumping facilities were sufficient to keep down the floods all this part of London was practically high and dry. For a town sewered on the system there adopted, its soil was also clean.

By the adoption of a similar process in Washington, such land as may be reclaimed from the river and the present lower portions of the city may be brought to a perfectly satisfactory state of drainage. This condition cannot be attained by any process depending on the discharge of sewerage and drainage at the natural level of the Potomac River.

If the rivers were confined within proper channels by suitable bulkheads or embankments, and if the lands behind these embankments were thoroughly drained to a sufficient depth, in connection with a sufficient subsoil drainage of the lower parts of the city, and were an independent house sewerage provided for the lower levels, the whole system being carried out in connection with adequate pumping arrangements, the removal of the sanitary evils of Washington, so far as filth and soil saturation are concerned, would become simple and secure.

Including the capitalization of the cost of pumping, the cost of this method of improvement would be far less than that of the other method proposed.

So far as the ultimate disposal of the foul sewage of the city is concerned there is reason to believe that the constant volume of flow in the Potomac would, at least for a long time to come, solve the problem in the most satisfactory manner, especially if the foul matters reaching the sewers from the houses were delivered in a fresh or undecomposed state directly into the stream.

All surface flow and the intercepted sewage of the higher portions of the city being carried across the reclaimed flats by elevated channels, the drainage water and low-level sewage would not be serious in amount. Without requiring any considerable pumping lift, there would be secured the same improvement of drainage that would result from a raising of the level of the whole lower part of the city 6 or 8 feet above its present grade. The invasion of the floods of the Potomac would be prevented, and Washington would become practically a high-lying, dry town, with dry and wholesome land quite up to the deep channels of the rivers on both sides.

Whatever improvement may be made in the interior and exterior drainage of the Executive Mansion, its sanitary condition cannot become what it should be until the above-described improvement of its surroundings, or the equivalent of this improvement, is secured.

The works indicated being executed in their entirety, as has been suggested, there is every reason to believe that it would become an absolutely healthy residence, and that Washington would become an absolutely healthy city.

GEO. E. WARING, JR.

Col. A. F. ROCKWELL,
U. S. Army, in charge of Public Buildings and Grounds.

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